Study on noise of precision panel saw

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Abstract: According to ZBJ65015-89 standard about noise level testing method of woodworking tool, the noise testing for MJ90# and MJC1125 precision panel saws was conducted by using model ND2 precision sound-level apparatus and double frequency wave filter. The testing results showed that the unloaded running noise source of precision panel saw was mainly from main saw blade and its aeromechanic noise was the largest. The rotating speed was determined as an important factor to impact dynamic characters of precision panel saw as the unloaded running noise increased along with speed increasing. For reducing noise of precision panel saw, the first important way is to reduce the aeromechanic noise produced by main saw blade rotating at high speed; based on assuring the processing precision, choosing low speed is a better way to drop dawn noise; from the view of design, the diameter of clamping lid is better of half of outer diameter of main saw blade.

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Introduction

Noise has harmful influence on human life. Firstly, it can drop down one's hearing ability, even cause deaf. Secondly, noise affects people's normal working, studying and rest. It is proved by tests that noise above 40dB(A) can influence the endocrine system of sleeping man; noise above 45dB(A) can disturb normal sleep of man; noise above 50dB(A) decrease the understandable degree of talks in classroom or meeting room; noise above 70dB(A) cause difficulty to make telephone call; noise above 90dB(A) make ears of human feel pain. Thirdly noise can be harmful to nervous, circulatory, digestive and endocrine system of human. To some extent, it can also cause neurasthenia and high blood pressure (Leung 2003). In order to protect the health of workers and pretend the environment not to be polluted by noise, on August 31, 1979, the Chinese Ministry of Health and the National General Bureau of Labor issued "the Health Standard of Noise in Forestry Enterprises" being performed from Jan. 1, 1980. It is provided in the Standard that "the noise standard should be lower than 85dB(A) in the workshops and working places of industrial enterprises, if some existing plants can not make effort to reach this standard, the standard can be looser but not higher than 90dB(A)" (Sun 2003). However, the noise made by most woodworking tools is higher than this standard. Therefore It is not only a main task for wood machinery designers to reduce or eliminate the noise made by woodworking tools, but also a major branch of wood machinery dynamic design theory. This paper approaches the source and theory of noise made by precision panel saw, getting the regular of this kind of machine tool, give some ways of decrease the noise, and afford calculable status for dynamic design of precision panel saw.

Main source of noise made by precision panel saw

In order to accustom to material character, precision of product and shape structure of knife, the precision panel saw has characters such as high speed (various speed be changed), simple transmission and structure and high processing precision, as a result, special source of noise arise. In spite of the main saw blade, this kind of tool has a sub blade, so it has two source system of noise. Generally, this kind of tool produces two kinds of noise: airflow noise (aeromechanic noise) and structural vibrate noise (Wang 1983).

Structural vibrate noise is made up from several parts as follows: the first is the vibrating noise of cutting blade or the work piece when the blade cutting the work piece; the second is rotating noise of main blade axle and sub blade axle. The rotating axle always produces eccentric force because of uneven of material, deformity of raw work piece, deforming during heat treatment, errors during processing and assembling and etc. When the axle is rotating, it produces centrifugal force, thus making vibrating noise. The third noise is from touch of mechanic parts. Solid materials can make noise when touching and giving force to each other, for example, the working platform make noise when moving back and forth. The fourth noise is in the process of passing force, while friction, rolling and collision can all make noise, and the mechanical parts vibration owing to uneven forces can make noise as well. The fifth is the noise of working motor itself.

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The main reason why airflow noise (aeromechanic noise) is produced is: when the cutting blade is vibrating, a flow speed V is formed around this area. The interaction among the flowing field, saw blade and sawtooth result in a waving force field (Lu 1992). As flow speed V changing, air vacuum, turbulent and vortex flow around the saw blade and the sawtooth will appear, making air vibration and result in aeromechanic noise. The aeromechanic noise produced by rotating circular saw blade has the characters of single resource, couple-polar resource and four-polar resource, so it is a complex sound sending procedure. High level noise sending out by precision panel saw hurt the operator's hearing, decrease working efficiency, as the noise send out along with huge amplitude of saw blade, this increase waste materials, speed up the abrasion of blade and drop down the surface quality of processing.

Testing methods

Testing machines and main parameters

The tested machines are model MJ90# made by Shenyang Band Saw Tool Plant and model MJC1125 made by Mudanjiang Wood Machinery Plant. The main parameters are shown in Table 1.

Table 1. Main parameters of tested machine

No.	Parameters	MJC1125	MJ90
1	Max processing length	2500mm	2500mm
2	Max processing height	60mm	80mm
3	Diameter of main blade	300mm	300mm
4	Diameter of sub blade	125mm	125mm
5	Speed of main saw axle	3000\4000\5000\6000r/min	4000\6000r/min
6	Speed of sub saw axle	11170r/min	9800r/min
7	Motor power of main saw blade	4kw	4kw
8	Motor power of sub saw blade	0.75kw	0.75kw
9	dimension	2855x2610x1035mm	2750x2650x1000mm

Testing environment

The test environment was according to ZBJ65015-89 standard about woodworking tool noise level testing method. The distance of tested tools to walls at four sides were all larger than 2 m, and background noise of every testing point were all 10dB (A) lower than tested tools. While testing, the tool had run normally, steadily and continuously for 15 min. The maximum speed of the tools was 6000 r/min.

Testing position

The testing position was according to ZBJ65015-89 standard about woodworking tool noise level testing method. As shown in Fig.1, vertical distance between testing point and outline surface of tool was 1 m and distance to floor was 1.5 m. By circling around the tool, we could find the largest noise position. Microphone was placed at height of 1.5 m to standing floor for the testing at operator's position. The largest noise level was recorded at all the test positions as the tested data to testing report.

Apparatus

Model ND2 precision sound-level apparatus and double frequency wave filter were used for accurately measuring noise, which were tested and qualified by Heilongjiang Measuring and Testing Office, during the period of validity. The "A" network of sound level apparatus was used for noise testing, that is, "A" sound level was the gist to evaluate the noise of machines. According to regulations in GB12557-90 of "Safety General Rule of Woodworking Tool Structure" about unload running noise, the maximum noise level of running precision panel saw at unload state is 83dB(A)

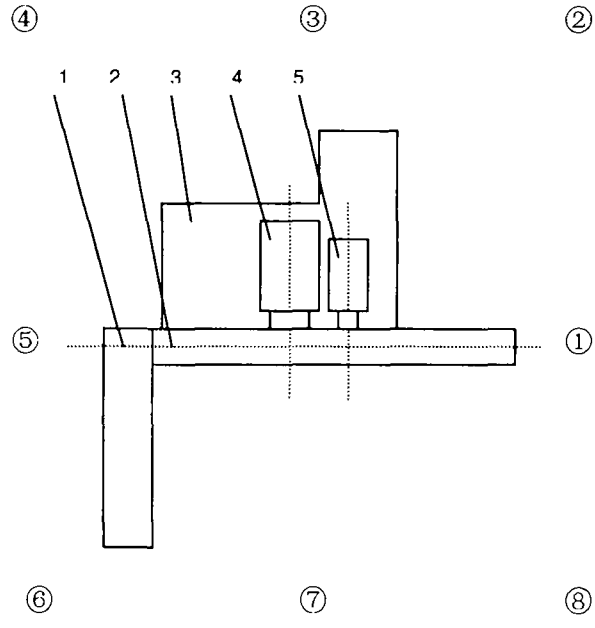

Fig. 1 Noise test position of precision panel saw

1. Plat for panel, 2. moving working plat, 3. working plat 4. main saw motor 5. line saw motor

The noise data of precision panel saw tested under different testing condition were shown in Table 2 and 3. The

noise test of MJC1125 precision panel saw was conducted in assembly workshop of Mudanjiang Wood Machinery Plant, with the background noise level of 39dB(A), while the noise of MJ90 was tested in Harbin Runfeng Furniture Plant, with background noise level of 38.6dB(A). The main saw blade and line saw blade of the two tested tools were the same size.

Analysis and discussion

, Test results as known in Table 2 showed that the unload running noise of MJC1125 was 72dB(A) for the condition without saw blade, 88dB(A) for the condition with main blade only, 73dB(A) for the condition with line saw blade when unload running, and 88dB(A) for that with both blades when unload running. Based on the tested data, it could be concluded that the unload running noise source of precision panel saw was mainly from main saw blade, and its aero-mechanic noise was the largest. Meanwhile, even though the speed of line saw blade was high, its noise was comparatively lower, thus the noises were almost the same in the case of only main blade fixed and both blades fixed. Since this tool has high precision, the influence of its own vibration to saw blade is rather little, and the noise also low. The noise at unload running condition of MJ90 was 0.5dB(A) lower than that of MJC1125 in respect to the highest sound pressure level while main saw blade and sub saw blade were all fixed on.

From Table 3 we can see that the unload running noise of MJC1125 precision panel saw was different at varied speeds, and it increased along with speed drawing up, that means the higher speed of motor the higher speed of air flow (see Fig.2).

Table 2. Sound level of each test point under different saw blade fixed condition dB(A)

Test point	Main saw and line saw blade unfixed		Only main saw blade fixed		Only line saw blade fixed		Main saw and line saw blade all fixed	
	MJC1125	MJ90	MJC1125	MJ90	MJC1125	MJ90	MJC1125	MJ90
1	67	71.2	80	80.3	66	71	80.5	81
2	69.5	70.8	83.5	83.5	68	70.5	83.5	83.5
3	69.5	72.7	87.5	85.3	70	72	87.5	86.3
4	71	72	84.5	83	70	71.5	84.5	83.5
5	68.5	73	84.5	83.3	69	73	85	83.5
6	67	70.2	82.5	81.3	66.5	71.2	83	81.5
7	70	71	86.5	84.6	70.5	71.3	87	85
8	65.5	68.3	81.5	81.6	66	69	81.5	82.4
Operate position	72	73.2	88	87	73	73.5	88	87.5
Test result	72	73.2	88	87	73	73.5	88	87.5

Table 3. Sound pressure data at different speeds and testing points of the product of Mudanjiang dB(A)

Motor speed (r/min)	Testing point								Operating position	Test result
	1	2	3	4	5	6	7	8		
3000	72	72.5	74.5	74	75	73	74.5	71.5	77	77
4000	74	75.5	79.5	76.5	77.5	76	78	73.5	82	82
5000	77	78	81.5	78	79.5	79	80.5	76	83	83
6000	80.5	83.5	87.5	84.5	85	83	87	81.5	88	88

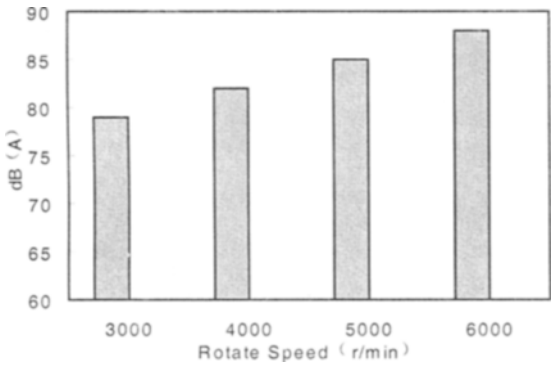

Fig 2 Relation between speed and noise

The noise of precision panel saw hurts the operator's hearing and reduces working efficiency. Moreover, since the huge amplitude of saw blade makes the noise, this will increase waste materials, speed up the abrasion of blade and drop down the surface quality of processing. Therefore, some ways to reduce the noise should be taken (Hou1993).

In practical work, there are three basic ways to control noise (Gao Yumei 1995): the first, low down the sound resource noise, that means reform the structure of sound resource, making low noise structural design, which is the root way to reduce noise. The second, control the noise on its spreading way, making the noise growing smaller on the spreading way, and reaching the goal to reduce noise. The third, adopt receivers and wear protection devices to pro-

tect, such as ear-stock, ear coating and helmet. As for the precision panel saw, we know from tests that unload running noise is mainly caused from main saw blade, in order to reduce noise, we should reduce the noise produced by main saw blade rotating. This paper will discuss as follows

Ways to decrease noise of precision panel saw

There are two kind of noise send out from main saw blade when unloaded running (Li 1997): aeromechanic noise and mechanical vibration noise. The mechanism of the two kinds of noise is different, so reduce noise of precision panel saw should be according to this.

Mechanical vibration noise comes from unbalance of main saw blade system, the main axle eccentric, loose of bearing and incorrect assembly. The efficient ways to reduce noise are as following: assure the concentricity degree of main axle, assure the assembly quality of gearing, and keep the saw blade balance. Furthermore, the edge of sawtooth can keep the saw blade balance. Owing to the highly-speeded circumgyrating of circular saw blade, any unbalance between the sawtooth processing will increase the vibration force and vibration noise (Zeng 1995).

Aeromechanic noise is mainly produced when the saw blade is vibrating. A flow field formed around this area. The interaction between the flowing field, the saw blade and the sawtooth result in a waving force field, thus making air vibration and resulting in aeromechanic noise. The main factors affecting the aeromechanic noise spreading are the speed of main saw blade, number of sawtooth, shape and size of sawtooth and stitch between sawtooth, and diameter of press lid, etc.. Basis on processing precision and productivity, the following ways could be adopted to decrease noise of precision panel saw: a) use low speed saw blade, since noise increase with the speed of main saw blade; b) use saw blade with more teeth; c) choose the best structural parameter of circular saw blade, decrease height of teeth, low down the back angle, the sawtooth area should be reasonable, not to be too large; d) use big diameter clamping lid, so to decrease noise level at high frequency, the diameter of clamping lid is better of half of outer diameter of main saw blade.

Conclusion

The unloaded running noise source of precision panel saw is mainly from main saw blade, and its aeromechanic noise is the largest. Taking model MJC1125 as an example, noise at operate position is 88dB(A) when rotating at speed of 6000 r/min, while the noise of line saw blade when unload running is rather small, 73dB(A) at operation position. The noise of the tool itself is even smaller, 70dB(A) in maximum. The unloaded running noise increases along with speed increasing. As a result, rotating speed is regarded as an important factor to impact dynamic characters of precision panel saw.

For reducing noise, the first important way is to reduce the aeromechanic noise produced by main saw blade rotating at high speed. Based on assuring the processing precision, choosing low speed is a better way to drop dawn noise. From the view of design, the diameter of clamping lid is better of half of outer diameter of main saw blade.

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